AU/ACSC/2926/AY2007

AIR COMMAND AND STAFF COLLEGE

AIR UNIVERSITY

THE SPACE TRIAD:

A JOINT CONCEPT FOR SPACE POWER

by

Charles S. Galbreath, Major, USAF

A Research Report Submitted to the Faculty

In Partial Fulfillment of the Graduation Requirements

Instructor: Lt Col David T. Hamm

Maxwell Air Force Base, Alabama

April 2007

Report Documentation Page

Form Approved
OMB No. 0704-0188

1. REPORT DATE	2. REPORT TYPE	3. DATES COVERED
APR 2007		**00-00-2007 to 00-00-2007**

4. TITLE AND SUBTITLE	5a. CONTRACT NUMBER
The Space Triad: A Joint Concept for Space Power	5b. GRANT NUMBER
	5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S)	5d. PROJECT NUMBER
	5e. TASK NUMBER
	5f. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) **Air University,Air Command and Staff College,225 Chennault Circle,Maxwell AFB ,AL,36112**	8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)	10. SPONSOR/MONITOR'S ACRONYM(S)
	11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release; distribution unlimited

13. SUPPLEMENTARY NOTES

14. ABSTRACT
see report

15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT **unclassified**	b. ABSTRACT **unclassified**	c. THIS PAGE **unclassified**	**Same as Report (SAR)**	**37**	

Disclaimer

TABLE OF CONTENTS

LIST OF FIGURES

Abstract

The United States is at a critical stage in its development in the space domain. The successful exploitation of space has simultaneously led to an unparalleled military advantage and an unintentional invitation to potential adversaries to develop means to deny and disrupt space capabilities. This paper identifies the conditions leading to this position and explores the viability of the new strategic triad as a template for space power. Consisting of offensive capabilities; defensive capabilities; a responsive infrastructure; and brought together by a core of situational awareness, command and control, and integrated planning, the space triad presents a balanced approach to space power development. Recognizing the inherent interrelationship of all operational domains, this paper discusses the space triad in the context of multiple domains and examines cross-domain operations. Within an illustrative vignette, the space triad demonstrates a potential to avoid or greatly diminish the impacts of a surprise attack against U.S. space capabilities. Finally, this paper discusses the implications, near-, mid-, and far-term, of adopting the space triad framework.

Path to a Space Triad

Space Power

The United States is at a critical stage in its development in the space domain. The successful exploitation of space has simultaneously led to an unparalleled military advantage and an unintentional invitation to potential adversaries to develop means to deny and disrupt space capabilities. The nation's space power is the total strength of capabilities to conduct and influence activities to, in, through, and from space to achieve national objectives.[1] Space power is an increasingly critical factor shaping U.S. security and America's way of life. Unfortunately, a combination of external threats and internal challenges are besieging U.S. space power. The U.S. must adopt a comprehensive strategy to deal with these diverse challenges.

The concept of space power is closely linked to the concepts of space control and space superiority. "Space control operations provide freedom of action in space for friendly forces while, when directed, denying it to an adversary, and include the broad aspect of protection of U.S. and U.S. allied space systems and negation of adversary space systems."[2] Space superiority is, therefore, the requisite degree of control over an adversary's space capabilities to ensure U.S. and allied forces can conduct and influence activities across the space domain.[3]

Space power is not only an enabler and force multiplier, requiring integrations throughout joint operations; but, can also be decisive by itself.[4] The intent of this paper is not to prescribe a handful of systems to resolve the nation's challenges in space. Rather, the objective is to identify needed families of capabilities and conceptually describe how those families should interact with one another, with other military capabilities, and within the suite of national power instruments, to preserve the U.S. advantage in space. A triad approach, consisting of offensive, defensive, responsive infrastructure capabilities tied together by situational awareness, command and control (C2), and integrated planning, is the best approach to space power and the only way to

assure U.S. space advantage in future crises. Before proceeding with a discussion of the space triad, it is important to understand the historic characterizations of the space domain, the utility derived from it, and the challenges facing U.S. space power.

Sanctuary or Control?

"If liberty and freedom are to remain in the Earth, the United States and its allies must be in a position to control space." – General Thomas D. White, USAF Chief of Staff, 1958[5]

General White's statement and associated discussion of space control and the need to consolidate space power development are striking in two regards. First, they are remarkable in their insight and foresight about the nature of space power and the criticality of the space domain. Second, and most regrettably, they highlight the realization that little has changed in the understanding and thought about space power in nearly fifty years. At the dawn of the space age, some, including General White, recognized space as a domain, similar to the air and maritime domains. This realization led many to see a need for space control, just as the United States could gain control of the air or maritime domains in a time of conflict. This control doctrine would create the abilities to assure freedom of action in space and to deny that same freedom to adversaries. President Eisenhower, however, directed a sanctuary doctrine.[6]

The desire to preserve space as a sanctuary largely stemmed from the need to have unrestricted means to monitor Soviet nuclear activities, thus reducing the fears and uncertainty of the Cold War. The sanctuary doctrine became the concept governing space development in the 1950s, 60s, and 70s. As a result, space activities largely fell into two camps: classified military programs and visible civil activities. In fact, President Eisenhower decided to create the National Aeronautics and Space Administration (NASA), separate from the Department of Defense (DOD), in part to preserve the sanctuary doctrine. Despite the development of anti-satellite weapons by both the United States and Soviet Union and the threat of the Soviet development of

a fractional orbiting bombardment capability, the sanctuary doctrine was the overriding principle until the 1980s.[7] For over two decades, the sanctuary doctrine provided a sound foundation allowing unimpeded monitoring of Soviet and American nuclear arsenals and thus maintained a stable, albeit tense, status quo.

In 1983, President Reagan proposed a shift from the existing doctrine to the development of missile defenses, including capabilities in space. This reinvigorated the space control versus space sanctuary debate for two reasons. First, orbiting missile defense capabilities might require protection to ensure they were viable to destroy incoming ballistic missiles. Second, orbiting missile defense systems would provide an inherent anti-satellite capability. While the United States hasn't fielded space-based missile defenses, other realities illustrate the need to supplant the sanctuary doctrine with a space control doctrine.[8]

In the 1980's, the establishment of Air Force Space Command (AFSPC) signified the emerging military utility of space systems beyond supporting purely national-level activities. This helped highlight the need to preserve future access to space and, if needed, deny the same access to adversaries. Before the standup of AFSPC, Air Force Systems Command developed, acquired, and operated the majority of all U.S. military satellites. The shift to the more "operations-oriented" AFSPC separated the development and acquisition of space systems from operations and helped focus space capabilities to support military operations vice strictly supporting national-level objectives.[9] This paid dividends during the 1991 Persian Gulf War, referred to by many as the first space war.

> U.S. ground forces used GPS (Global Positioning System) satellite data to easily navigate the nearly featureless desert landscape and even at night. DMSP (Defense Meteorological Satellite Program) weather satellites provided vital data on sandstorms, surface winds and other conditions that affected our troops and air operations. DSP (Defense Support Program) early warning satellites provided the essential first warning of Iraqi Scud missile attacks on coalition bases and Saudi and Israeli cities. Although delivered via an ad hoc reporting arrangement, this

> vital 'heads up' assisted U.S. Patriot missile batteries in engaging many incoming Scuds. The Gulf War then was the first major conflict in which the American military heavily relied on support from space systems.[10]

The result of the United States' successful space exploitation during Desert Storm brought about an intense interest in furthering space capabilities and their utility to combat operations and daily life.

Utility of Space

After the Gulf War, the utility of space capabilities to military operations continued to grow. Today, space capabilities enable modern warfare, through the reach-back capabilities offered by satellite communications, precision engagement and navigation enabled by GPS, the ability to control unmanned air vehicles from halfway around the world, the availability of high resolution imagery anywhere on the planet, real-time monitoring of location of friendly forces, vital support to combat search and rescue, etc. Additionally, the civilian sector increased its exploitation of space.

Beyond the military advantages of space are the day-to-day, often unseen or overlooked, benefits of space enjoyed by the nation and the world. For example, satellite communication and the timing signal of GPS enable global electronic financial transactions. The reliance on space has led some to call space an economic center of gravity or even an economic Achilles Heel.[11] Further, space itself has become a boom industry for the nation; with commercial satellite imagery; satellite communication, television, and radio; GPS user equipment; and the newest space industry to emerge, space tourism. These facts are critical considerations as the nation moves forward to develop its space power. Naturally, potential adversaries have watched and taken note of the U.S.'s exploitation and growing dependence on space capabilities.

Threats to Space Capabilities

The intelligence community has clearly enumerated the threats to U.S. space systems. In 2005, the National Air and Space Intelligence Center published *Challenges to U.S. Space Superiority*. This document identified foreign interest and development of space object surveillance and identification; as well as technologies to attack the ground, link, and space segments.[12] In a recent Congressional Testimony, Lieutenant General Michael D. Maples, Director of the Defense Intelligence Agency, stated that while Russia and China are the primary states of concern, numerous other states and non-state groups are actively seeking capabilities to counter U.S. exploitation of space.[13] Recent events clearly illustrate these threats are coming to fruition.

A few widely publicized incidents stand out. While not particularly effective, the first adversary use of counter-space weapons in combat occurred during Operation Iraqi Freedom. The Iraqi regime attempted to counter the U.S. utilization of the GPS constellation through a series of ground-based jammers. Like their military counterparts, commercial systems are not immune from attack. In 2003, there was an intentional jamming of two transponders of Telstar-12, disrupting broadcasts to Europe and the Middle East. The apparent target was a Voice of America Persia broadcast intended for Iran.[14] More recently, reports indicated Chinese use of ground-based lasers to dazzle imagery satellites. Finally, 2007 began with a Chinese demonstration of a direct ascent, kinetic kill anti-satellite (ASAT) system.[15] Even if a direct confrontation with China is a slim possibility, in an age of rapid technical exchange, the U.S. may have to face these or similar threats in future crises. In the coming years, the potential for attacks against space systems, by state and non-state adversaries, becomes increasingly possible. Clearly, space is no longer a sanctuary.

Troubled Acquisition

"As I see it, our nation's dominance in space is being challenged not so much from outside this country but from within. In many respects, we have become our own worst enemy…The problem, ladies and gentlemen, is not the operation of the satellite. Once it gets to space, our satellites rarely disappoint. Rather, our greatest challenge lies in the development and building of the satellite." – Senator Wayne Allard, 2005[16]

Tendencies to stovepipe space capabilities, lengthy acquisition development timelines, and cost overruns often keep the U.S. from maximizing it's utilization of, and advantage in, the space domain. While similar criticisms are possible for any major defense acquisition effort, the unique nature of space capabilities magnifies the impact of developmental difficulties.

Acquisition is particularly critical in space power discussions due to the nature of a typical life cycle cost profile associated with space systems. As shown in Figure 1, the majority of non-space systems costs occur after a low rate initial production (LRIP). The procurement of additional systems after LRIP coupled with sustainment and operations causes this effect. For space systems, however, there are very few additional systems to procure. Additionally, sustainment and operations costs are negligible, due to the inability to service or upgrade space assets once in orbit. This places greater emphasis on early stages of a space system's acquisition.

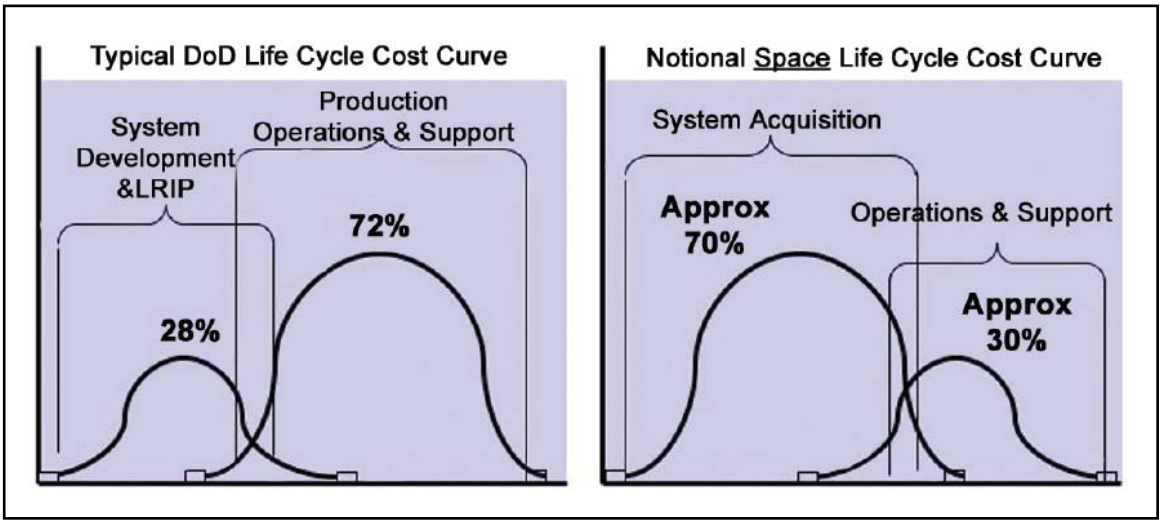

Figure 1: Life Cycle Cost Comparison[17]

In 2005, the General Accountability Office (GAO) identified a cycle of pressures resulting from starting too many space programs with insufficient funding (Figure 2).[18] The GAO warned that unless the DOD implemented changes, this process would continue to plague space acquisition. While the GAO's assessment is accurate, space acquisitions do not occur in isolation. In addition to the troubled acquisition process, there are also many operational and personnel ramifications of this pressure cycle.

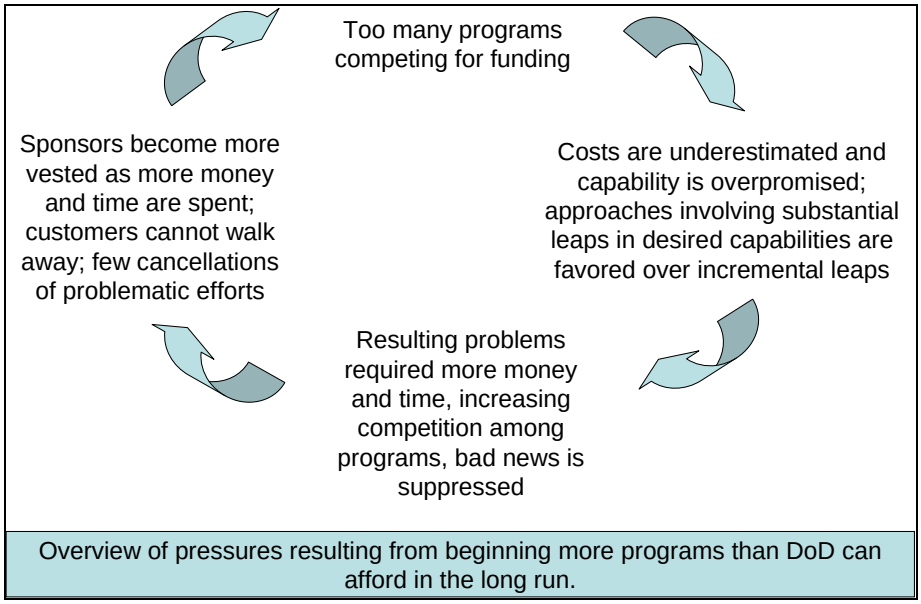

Figure 2: Acquisition Pressures

As the United States military fields fewer new systems, the criticality of each operational system increases. Based on the recognized benefit of these systems and their small number, the proliferation of ASAT capabilities may lead potential adversaries to see these systems as lucrative targets. Coupled with the lack of immediate replacement, this creates a precarious protection strategy.

The desire to standout amongst the competition and capture scarce procurement dollars leads many system developers to seek breakthrough, proprietary technologies rather than using proven and more widely available technologies. Compounding this is the number of different

national security organizations operating space systems, each with their own concepts and approaches.[19] The resulting stovepiped systems are difficult to integrate with one another and limit the flexibility needed to respond to dynamic situations.

Finally, the combination of increased budget pressure and lengthy development timelines lead to a reduction in the military space professional cadre. As the 2001 Space Commission Report identified:

> The aerospace and defense industries overall have seen their appeal battered by declining stock prices, steady layoffs, program failures and cost and schedule overruns. Without a sufficient base of interesting, leading edge technology programs, it is increasingly difficult for both industry and government to attract and retain talent.[20]

The shrinking pool of talent decreases the nation's industrial base and ultimately its relative competitiveness to other nations or to commercial space programs.

Preserving Space Capabilities

From the previous discussions, it is clear the United States must pursue avenues to ensure space capabilities. The current national space policy follows the prophetic words of General White, comparing the importance of freedom of action in space to earlier needs of air and sea power. Further, recognizing this growing criticality it states:

> The United States considers space capabilities -- including the ground and space segments and supporting links -- vital to its national interests. Consistent with this policy, the United States will: preserve its rights, capabilities, and freedom of action in space; dissuade or deter others from either impeding those rights or developing capabilities intended to do so; take those actions necessary to protect its space capabilities; respond to interference; and deny, if necessary, adversaries the use of space capabilities hostile to U.S. national interests.[21]

Without explicitly calling for it by name, the current space policy identifies the need for space superiority. Critics declared this new policy, the first update in over ten years, as overly aggressive, unilateral, and a prelude to weapons in space.[22] Supporters of the policy highlight the fact that the new policy is simply a documentation of the logical evolution of existing policy

in the context of the 21st Century. Most debate about the new policy has largely been silent since the Chinese demonstration of ASAT capabilities, in early 2007. Even detractors of the new policy seem to agree that there are real threats the U.S. must face in the space domain. The U.S. objective in space is clear: the United States must preserve its ability to control space to enable successful space exploitation in future crises.

Previous Three-Part Constructs

The U.S. advantage in space is facing significant challenges, from both outside threats and internal struggles. The environment of change, uncertainty, and an expanded set of potential threats which drove the United States to revise the strategic triad uniquely matches the challenges facing the space domain. Therefore, a valid way to ensure all critical aspects of space power are addressed is to follow the construct laid out within the new strategic triad. Previous efforts have adopted similar models with mixed results. A clearer understanding of the new strategic triad and previous three-part approaches to space power provide an interesting and useful bearing.

The New Strategic Triad

When the Cold War ended, the United States found itself facing an increasingly uncertain world of global antagonists. Gone was the certainty of the monolithic Soviet Union as an adversary. In its place are a myriad of potential adversaries, ranging from non-state actors to a burgeoning near-peer competitor. Gone, too, was the concept that the nuclear triad alone could effectively deter the growing list of potential adversaries. Recognizing the need for an expanded set of capabilities to meet the challenges facing strategic deterrence in this new environment, the 2001 Nuclear Posture Review recommended transitioning from the traditional nuclear triad of bombers, ICBMs, and submarines to a new triad with a balance of offensive, defensive, and infrastructure capabilities (Figure 3).[23]

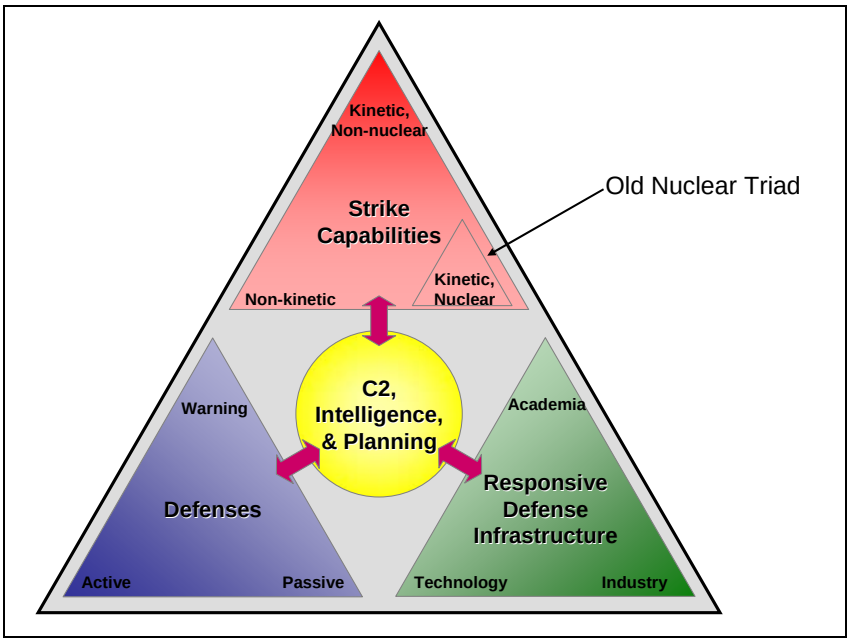

Figure 3: The New Strategic Triad

Offensive capabilities, once exclusively nuclear, now include capabilities to strike targets via non-kinetic and kinetic, non-nuclear means, in addition to the traditional nuclear means. Regardless of the strike method, precision is the principle factor. The expanded range of precise capabilities affords the President greater flexibility to deal with the growing list of potential scenarios.[24]

Realizing the threat of force alone would not deter all potential adversaries, the new triad includes defensive capabilities as one of the legs. In the strategic triad, defensive capabilities begin with warning and move to a combination of active and passive defenses. The objective is to examine defense in a holistic manner to nullify an attack, with layered and integrated capabilities, rather than a single point solution.[25]

The third leg of the new triad is a responsive infrastructure which requires capabilities able to adapt emerging technologies to the changing environment. The infrastructure must be diverse and resilient, able to deliver new and innovative capabilities as needed, rather than

creating stockpiles of systems. Components within the responsive infrastructure leg include: technology, industry, and academia.[26] The underlying theme of a responsive infrastructure is to explore innovations to prepare the U.S. for the uncertain nature of future conflicts.

Tying these three legs of the new triad together is a core of C2, planning, and intelligence capabilities. Here, the objective of C2 is to push integrated intelligence information to those needing it and produce rapid decision making at the appropriate level during the development and execution of plans.[27]

As a whole, the objective of the new triad is national security, in the context of multiple and diverse potential adversaries. In a similar manner, a space triad concept can integrate and balance the offensive and defensive capabilities traditionally considered in space power discussions with the need for a responsive infrastructure, an area researchers and current Joint and Air Force doctrine often overlook, or do not adequately cover, when addressing space power.[2829]

Previous Space Power Approaches

The concept of applying a three-part construct to the space domain is not a new one. Over the years, various attempts to adopt both the nuclear triad and new strategic triad to the issue of space have met with mixed results.

In the 1990s, Moyle applied the nuclear triad to suggest the U.S. needed a fleet of space bombers, lasers, and space-based radars.[30] This approach clearly focused on systems rather than capabilities and did not include the balanced approach found in the new strategic triad. Further, this approach did not address the required level of integration between space and other military instruments.

In 2006, two efforts applied the three-part approach to the issue of space superiority. First, Harter identified assured access to space, through spacelift, as the prerequisite for space

superiority. The second segment is counterspace operations, consisting of: space situational awareness (SSA), offensive counterspace (OCS), and defensive counterspace (DCS). Finally, Harter emphasized the need for effective space command and control.[31] Fundamentally, Harter correctly identified the components, but did not extend assured access to space beyond spacelift and sequestered major sections, such as SSA, to a subset under counterspace operations.

Also in 2006, Jones applied the new triad to put forward a concept with OCS capabilities, SSA capabilities, and joint warfighting space. This approach equated the infrastructure leg of the new triad to joint warfighting space, an effort to rapidly develop and launch space capabilities directly for a Joint Force Commander. It also deviated from the new strategic triad by replacing the defensive leg with SSA, suggesting instead of a single leg the entire approach provided for a defensive capability.[32] The inclusion of SSA correctly integrates this key aspect of space power. Certainly, warning of attack, as found in the defensive leg of the new strategic triad, is a critical element of SSA; however, SSA could also be linked to the intelligence capability at the center of the new triad. Additionally, there are many unique defensive activities and capabilities contributing which should be included in a space triad. For these reasons, a better position for SSA is within the core activities of C2, returning defense as a leg of the triad.

These three approaches represent good attempts at laying the foundation for space power within a three-part construct. Particularly useful points include Harter's acknowledgment of space superiority beginning with assured access to space and Jones' elevation of SSA to the appropriate level. However, each suffers from certain shortcomings. Unlike Moyle's system-centric approach, a conceptual framework should identify capabilities. While Harter stresses the importance of assured access, spacelift alone is not sufficient. Assured access also requires on-orbit operations, sustainment, and to a greater extent even acquisition, research, and development activities. Finally, even though a space superiority framework will ultimately lead

to a deterrent position, it is not the only defensive capability needed. A closer tie to the current strategic triad is required. These issues highlight the need for a more robust and complete space triad construct.

The Space Triad

As illustrated in the discussion of previous space power constructs, none fully captured the essence of the strategic triad nor provided the holistic and balanced framework to address the external and internal challenges facing the U.S. space advantage. The objective of adopting the space triad is to possess the ability to maintain an advantage in space, thus enabling effective combat support and operations from space. The proposed space triad represents the needed capabilities to achieve desired effects in the space domain and in those areas directly enabling operations in space. Like the current strategic triad, the space triad consists of the three main sections (offense, defense, and responsive infrastructure) brought together by an integrated situational awareness, command and control, and planning core. While the overall objectives of each section are the same, based on the unique nature of space operations vis-à-vis strategic deterrent operations, the components of each section differ slightly from the strategic triad.

The Space Triad in Multiple Domains

Before proceeding with an in-depth discussion of each subset of the space triad, it is vital to discuss the interrelationship of the space domain to other military domains. The Capstone Concept for Joint Operations (CCJO) identifies nine domains to influence a target system. The CCJO groups these nine domains into the physical domains of air, land, sea, and space; the virtual domains of cyber and information; and the human domains of social, moral, and cognitive. The CCJO stresses the importance of acting from multiple domains in an integrated and interdependent manner.[33] Since the human domains will depend on a particular adversary or operation, they are beyond the scope of the general discussion associated with the space triad.

Further, while all nine domains are relevant for military discussions, only the air, land, sea, space, and cyber domains currently have concerted militarily operational efforts. Therefore, these five domains are the focus of domain discussion related to the space triad. Three key points are important to highlight before continuing the space triad discussion.

The first key point is that while each domain has inherent specialties, all domains provide combat support. Therefore, some doctrinally defined space missions are simply part of a larger set of inter-domain missions (Figure 4).[34] Space force enhancement (SFE) and space force application (SFA) missions, for example, are combat support and combat operations, respectively. While part of the overall space power family, they are not means to assure space power. Consequently, these mission areas are outside the scope of the space triad discussion.

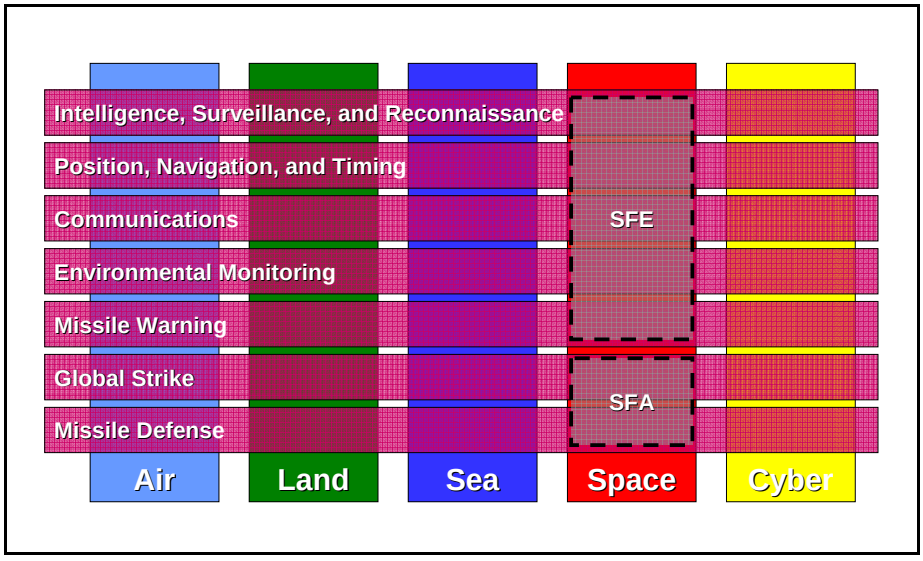

Figure 4: Space Missions and Domains

Second, even though all domains interact, the linkage between the space and cyber domains is particularly acute. More than any other domain, space is dependent on the cyber domain. Since the cyber domain encompasses the entire electromagnetic spectrum, all information and services from space transit the cyber domain.[35] Due to the extreme ranges

involved in space operations, the day-to-day control of space systems must occur via the cyber domain. Additionally, many threats to space systems are from the cyber domain, including lasers, jamming systems, and network attacks. As the space and cyber domains evolve, this interaction will undoubtedly also evolve. However, as an entering point for discussion, the cyber domain is a unique domain. Therefore, many of the aspects traditionally considered space operations are cyber operations and beyond the scope of the space triad.

Finally, while space is typically a supporting domain, when necessary, the other domains can provide support to achieve the desired space effect. For example, a ground or cyber attack against an adversary's satellite control facility may achieve the desired level of space denial without entering the space domain itself. To maximize combat utility and economy of effort it is essential to integrate the planning, C2, and situational awareness of all domains, as identified in Figure 5. With these points understood, a detailed discussion of the space triad is possible.

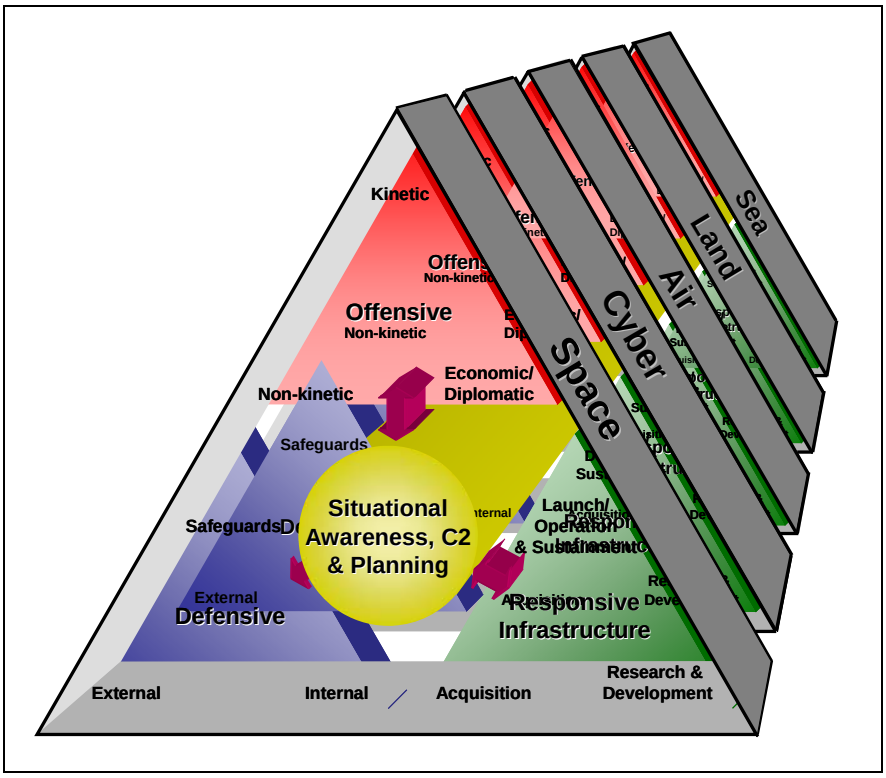

Figure 5: The Space Triad and Domain Interaction

Offensive Capabilities

Within the offensive section, the goal is to possess the ability to deny an adversary the benefits of space. Like the new strategic triad, the desire for precision pervades all aspects of offensive capabilities. Unlike the new strategic triad, nuclear options are not applicable within the space domain. This restriction is based on Article IV of 1967 Outer Space Treaty banning nuclear weapons in orbit, the desire for precise effects, and the political and military ramifications of a nuclear strike.[36] In short, use of nuclear weapons for a space superiority objective would fundamentally change and escalate the nature of the operation.

In place of nuclear options are diplomatic and economic means to dissuade or hinder others from developing or fielding space capabilities counter to U.S. interests. One example of such an approach is the Outer Space Treaty limiting certain actions in orbit. The White House has repeatedly stated the U.S. "will oppose the development of new legal regimes or other restrictions that seek to prohibit or limit U.S. access to or use of space."[37] This restraint does not prevent the U.S. from using political and economic means entirely. For example, the United States has recently entered agreements with private satellite providers to preclude adversary access to space-based imagery. This option has worked in the past; however, as space capabilities proliferate, it may become economically impractical to rely on this method. The inclusion of economic and diplomatic capabilities highlights the need to integrate all available capabilities and instruments of national power to achieve the desired national objectives.

Economic and diplomatic methods are practical in a long-term, deliberately planned approach to help shape the environment of future operations. Unfortunately, crises will emerge, requiring quicker response options. For these instances, the United States must develop both kinetic and non-kinetic means of denial. While in a general sense, economic and diplomatic means of space denial are non-kinetic, the distinction of who delivers a non-kinetic capability

necessitates a separate sub-category. Within the space triad, non-kinetic means refers specifically to military actions.

Military non-kinetic capabilities represent an escalation beyond the economic and diplomatic options discussed earlier. Even with this escalation, non-kinetic means offer three distinct advantages. First, with their escalation they can more emphatically convey national will. Second, they offer the ability for rapid restoration of an adversary's capabilities upon cessation of hostilities. Finally, unlike kinetic options, non-kinetic options are capable of achieving their desired effect without the danger of causing orbital debris.

The final subset of offensive capabilities is kinetic options and represents the highest level of escalation and the greatest risk of suffering unintended consequences. Co-orbital and direct ascent ASAT weapons are not reversible and will likely cause orbital debris, with significant long-term consequences. Additionally, despite the fact that space is not a sanctuary, kinetic options will likely be widely condemned by the international community and many within the U.S. for the foreseeable future. Further, as multination partnerships and civilian conglomerates continue to expand their delivery of satellite technologies, kinetic options will become less appealing, due to the inability to avoid collateral damage. The one distinct advantage of kinetic options is the relative ease of battle damage assessment.

Defensive Capabilities

The United States is now, and will likely remain, the nation most reliant on space capabilities to effectively conduct military operations and sustain its way of life. As discussed earlier, U.S. space capabilities are increasingly becoming targets by those seeking to eliminate its advantage in space. Additionally, the operating environment of space is inherently dangerous and becomes more dangerous as the level of manmade space debris increases. For these reasons, the United States must devote considerable attention to defending and protecting its space

capabilities. This defense not only provides security for specific platforms, but more importantly for the type of capability provided from space and the U.S.'s assured access to key regions of space, what Klein calls celestial lines of communication. These celestial lines of communications are points commonly used or transited including low earth orbit, geosynchronous orbit, and the Lagrange points.[38]

Two factors characterize the types of defensive options: the timing and the focus of the action taken. As illustrated in Figure 6, the level of available warning and timing of an attack or incident characterizes the level of threat. The three levels of timing are ambiguous warning, unambiguous warning, and post attack/incident. The focus of action can either be internal to U.S. and friendly capabilities or external and focused on diminishing the effectiveness and/or duration of the adversary's attack or incident. During a period of ambiguous warning, the U.S. must seek safeguarding measures to assure successful delivery of space derived capabilities and continued use of key space staging points. Safeguarding measures can include a wide variety of means including, hardening, redundancy, maneuverability, etc. After unambiguous warning is received, but before an attack or incident commences, the U.S. can choose to preempt an adversary attack or initiate measures to avoid the attack/incident. In some cases, this may mean implementation of safeguarding measures. Once an attack commences or incident occurs, the U.S. can suppress the attack and take action to restore the lost or degraded capability.[39]

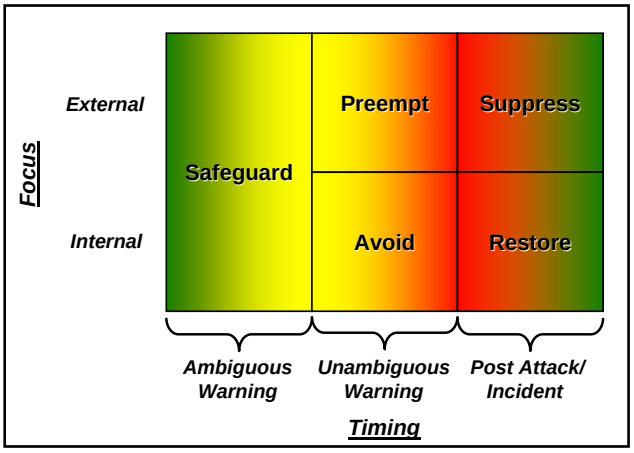

Figure 6: Defensive Options

The combination of all defensive options affords the greatest amount of flexibility to the nation and creates a multi-layered defensive posture. Within the context of a specific situation certain defensive options may be less desirable than others. Given the growing uncertainty of future conflicts and the range of potential challenges, it is only prudent to have a flexible defensive architecture. Only through the planned development of all available defensive capabilities will future commanders have the flexibility and ability to effectively implement the appropriate response to a given situation. Further, the totality of defensive options creates a formidable barrier for any would-be attackers.

Responsive Infrastructure

While the strategic triad examines technology, academia, and industry as the three subcomponents of responsive infrastructure, the space triad focuses on capabilities.[40] This approach maintains the parallel among the main sections of the triad. While technology, academia, and industry are all essential to a responsive space infrastructure; the focus should be on the capabilities these entities provide or rely on. Therefore, the responsive infrastructure of the space triad is: research and development (R&D), acquisition, and satellite launch, operation, and sustainment.

Space systems do not simply appear and support military operations. A dynamic combination of talented people, flexible processes, and robust products is required to obtain access to the space domain. Scientists and engineers must research and develop required technologies. Engineers and program managers must acquire systems and incorporate those technologies. Finally, operators must launch, operate, and sustain the systems. These three areas are as critical to space power as they are technically challenging. Each area is keenly interrelated with the others, increasing the potential consequence of the many difficulties associated with the acquisition process, identified earlier.

R&D contributes to space power in three primary ways. First, R&D is critical to mature technologies for later use in operational systems. New advancements must undergo a series of tests to ensure the technology is operationally feasible and suitable for the space environment. Second, R&D efforts can provide operational utility once the demonstration of the viability of the technology is sufficiently complete. Research efforts, should ensure any residual capabilities are available for post-test operational planning and use. To improve the ease of transition, the operational community must be knowledgeable of the effort from the beginning. Overly restrictive classification measures often prevent this. Finally, the pursuit of new technologies can serve as a deterrent to potential adversaries or lead them to pursue avenues advantageous to the United States. For example, consider the massive spending effort by the Soviets to counter President Reagan's proposed Strategic Defense Initiative during the Cold War.

Provided with proven technologies from previous R&D efforts, the acquisition community can now produce operational systems. System planners must be mindful of the protection concerns associated with overloading capability on a single platform and consider smaller, single purpose platforms or systems with smaller mission sets. This will shorten development timelines and decrease overall program costs; while simultaneously reducing the criticality of any one satellite, thus improving the U.S. defensive posture. While the use of single purpose systems will require extra launches, the smaller payload may enable the use of smaller, therefore less expensive, boosters. Assuming no major breakthrough in launch technology, putting satellites in orbit will continue to be an expensive and time consuming proposition. However, the operational community can take steps to improve the responsiveness of these activities.

Shifting to increased use of smaller payloads opens many options in the launch, operations, and sustainment realm. As previously mentioned, smaller payloads will lead to the

use of smaller boosters. These smaller boosters may allow the utilization of an expanded suite of launch systems and bases, including the use of air and sea launch vehicles. This will decrease the reliance on the two U.S. launch ranges, decrease time to place payloads in orbit, and make the U.S. less susceptible to a catastrophic incident at any one launch base. Once in orbit, space systems require operations through interoperable, net-centric satellite C2, to ensure the health, status, anomaly resolution, and support to users.[41] Adopting a net-centric approach to satellite control will enable a more rapid check-out of newly launched satellites, greater number of contacts per day to support the increased number of payloads launched, and decrease the significance of any single ground station. Finally, with a decreased time to launch and increased capacity for satellite control, the prospects of launching supply, repair, and upgrade missions increase. This will improve the flexibility of the U.S. space infrastructure. Further, this new-found flexibility enables many of the defensive and offensive means of achieving national and military objectives.

Situational Awareness, Command and Control, and Integrated Planning

A combination of situational awareness, C2, and integrated planning enables all space operations. Situational awareness provides the requisite knowledge for current operations, as well as an assessment of the projected space situation to guide research and acquisition activities. C2 coordinates and directs available capabilities to accomplish the needed missions. Interwoven within C2 is the need to conduct integrated planning to determine the optimum use of available resources, regardless of domain. Again, recognizing the interrelationship of all operational domains, these three functions must pervade and unite activities in space, cyberspace, air, land, and sea.

SSA is a necessary, but not sufficient, facet of space power. While there may be some inherent deterrent capability in monitoring space activities and ensuring potential adversaries are

aware of that capability, SSA alone is not enough. Therefore, SSA must focus on enabling other functions within the space triad. To accomplish this, SSA must provide current status and projections of friendly, neutral, and enemy space forces, and the operational environment. This includes the need to assess adversary intentions, in the near-, mid-, and far-term. Further, SSA must be able to predict, identify, and attribute attacks against friendly space capabilities. Finally, situational awareness must extend beyond the space domain and include insight into air, land, sea, and cyber activities of potential consequence to space operations. All of this information must be available within a user defined interface to support effective planning and C2.

Fundamentally, space C2 must translate national objectives and the Joint Force Commander's intent and objectives into actionable tasks, direct appropriate forces to accomplish those tasks, and assess their effectiveness.[42] To accomplish these roles, the United States must have a means to effectively connect operational units, Joint Functional Component Command (JFCC)-Space, other JFCCs, forward headquarters, and agencies in a net-centric and collaborative environment. With JFCC-Space serving as the central control for space activities, networked C2 will ensure appropriate execution of space tasks around the world. This interconnected C2 capability makes an integrated planning process with diverse cells around the world possible.

Given the limited availability of space resources and their continued criticality to military operations, an integrated planning process is vital to ensure maximum utility to the greatest number of operations around the world. An integrated planning process can ensure operations in all domains interact to achieve desired objectives and avoid costly duplication of effort, or worse, unintentional degradation of friendly capabilities. On a global scale, this integrated planning may see space activities simultaneously act in both supporting and supported roles. Whatever

the role, clearly integrated situational awareness, C2, and planning capabilities are essential to ensuring the U.S.'s space power today and into the future.

Application

While the binning of capabilities within offensive, defensive, and responsive infrastructure sections allows for clearer discussion, it does not mean these capabilities serve a single function. For example, robust SSA capabilities may help deter potential adversaries from taking provocative actions the U.S. will undoubtedly monitor. Also, the capabilities of a responsive infrastructure are instrumental in enabling the rapid restoration of lost capabilities. The following vignette illustrates this point.

The 2001 Space Commission Report warned of a "Space Pearl Harbor."[43] While some think this warning was alarmist in nature, such a concept does represent the most dangerous course of adversary action.[44] For that reason, it is worth investigating to determine how the space triad might prevent or diminish the severity of such an attack. First, it is important to understand the context, objectives, and means potentially embodied by a "Space Pearl Harbor" attack.

Assuming conflicts will continue to be waged for terrestrial objectives, a "Space Pearl Harbor" will likely be a prelude to an imminent terrestrial attack or a final effort by a desperate adversary to slow or halt advancing U.S. and allied forces. If the latter is the case, the identification of the adversary "doomsday" capabilities must be a high priority early in the conflict, so the U.S. can take appropriate preemptive measures. While this may stress situational awareness capabilities, it does not represent a surprise attack and is not the most dangerous of enemy options. Therefore, the former case seems the more interesting of the two.

To effectively utilize all available options in a surprise space attack, a potential adversary will require technical skills and staging points. Such robust capabilities are reasonably only

available to state actors, most likely a near-peer competitor. Presumably, such an adversary will be reliant, to some extent, on space capabilities themselves. Their logical objective would be to nullify U.S. space capabilities, while preserving their own, as a precondition to engage in terrestrial operations. This attack may manifest rapidly, to overwhelm the U.S. ability to respond, or gradually, attempting to imperceptibly erode the U.S. advantage in space. In either case, through effective use of the capabilities identified in the space triad, the United States can prevent an adversary from achieving their desired precondition and ultimately avoid a direct conflict.

All of the components of the space triad play a part in preserving U.S. space advantage, thus avoiding a conflict on the adversary's terms. First, due to robust multi-tiered defensive options a potential adversary will have to employ a variety of techniques to attack U.S. capabilities. Each means of attack, jamming, ground-based laser, direct ascent or co-orbital ASAT, computer attack, etc., carries its own intelligence and preparation requirements. The combination of preparations for a space attack coupled with the preparation for terrestrial operations will undoubtedly raise warning flags for situational awareness to detect. With this warning, national and military leadership can plan and coordinate a variety of response options. Due to the adversary's use of space, one option includes holding their capabilities at risk. Should a determined adversary continue with their intentions, a responsive infrastructure will ensure any degradation to U.S. space systems is short-lived and capabilities rapidly restored. The result is a disruption in the adversary's plan to deny U.S. space capabilities and a prevention of their objectives.

While this short vignette represents an extreme case, certain aspects are applicable to more likely scenarios. Certainly as ASAT technologies proliferate, future crises will contain some level of threat to space capabilities. As this scenario illustrates, in the future conflicts,

space will not only be an enabler for terrestrial operations, but may also be decisive in confrontations between political wills.

Implications of the Space Triad

Analysis of the space triad and its potential role in future crises identifies several implications for the development and sustainment of space power. Near-term implications largely center on changing perceptions of space power, its interaction with other domains, and how best to utilize space services. Mid-term implications focus on transforming the U.S.'s space power approach and joint space organizational culture. Finally, far-term implications deal with the need to solidify the transformation through organizational change.

Near Term

Immediate implications deal with the U.S.'s, especially the DOD's, perceptions of the cyber domain, space-derived services, and openness of space power capabilities. These perceptions unintentionally lead to inefficiencies and barriers to the full exploitation of space.

The concept of cyber including everything in the electromagnetic spectrum creates a span of authority too large to effectively manage. The DOD must responsibly pare down the definition of cyber to allow for a realistic operational approach. With this in mind, systems operating in other domains, whose primary function are to achieve a space effect, should be under the same development and control as pure space systems. For these reasons, the purview of space operations should include those cyber capabilities dedicated to achieving a space effect. This does not mean those operations occur in isolation; they must be properly coordinated and integrated with other domain operations, to ensure maximum effectiveness and to minimize unintended interference.

The perception of space-provided services as special or unique ultimately limits their full exploitation. As discussed earlier, space force enhancement and space force application missions

are actually subsets of larger cross-domain operations. Views to the contrary support the development of stovepiped systems, making effective integration more difficult. The space community must recognize this fact to develop new systems and integrate capabilities accordingly.

Underpinning these misperceptions is a lack of openness about space capabilities. Internally, this lack of transparency hinders integration of capabilities and prevents adequate planning to maximize effectiveness and minimize limitations. Externally, it leads potential adversaries to misperceive U.S. capabilities and intentions. While this may be advantageous in some respects, it ultimately degrades a deterrent strategy. The lack of transparency appears to stem from the two space sectors created by the space sanctuary doctrine. With the end of the Cold War and of the sanctuary doctrine, it is time to set aside previous views and adopt a more open approach.

Mid Term

The United States must move to transform its approach to space power. This transformation centers on the space infrastructure and organizational culture of the joint space professional cadre.

Greater emphasis is required in the R&D sector to mature technologies, prior to their infusion into space systems. Integral to the use of responsive boosters is a shift in the spacelift portfolio to include increased use of smaller payloads. This balanced approach will enable a larger variety of launch options, including emerging commercial capabilities. This shift of approaches will take time to fully implement, but efforts such as Tac-Sat and Operationally Responsive Space are already leading the way.

Cultural transformation is needed to increase the integration of acquisition and operation professionals and the level of jointness in space power development. The space triad illustrates

the acute relationship between space operations and acquisition. As a result of the Space Commission Report, Air Force space acquisition is part of Air Force Space Command, which is also responsible for operations. Further, space acquisition personnel are part of the growing space professional cadre, able to wear the space badge and compete for command of operational squadrons. However, until an integrated career path for scientists, engineers, and space operators exists, there will be cultural barriers to the development of space power. To a lesser extent cultural artifacts such as uniforms and specialty codes, must also reflect a unified approach.[45] Finally, space professionals must embody a joint philosophy and outlook. Cultural parochialism must give way to reflect the interdependent reality of space operations. This must occur in all areas of the space triad to ensure capabilities are developed, fielded, operated, planned, defended, and implemented in a joint manner.

Far Term

Enabled by accurate perceptions of space power and the establishment of a truly joint space culture, a new organizational approach is the final step to realize the full potential of the space triad approach. As noted earlier, the inception of NASA, parallel to the military's space efforts, was in large part due to the desire to make space a sanctuary. Understanding space is no longer a safe haven, coupled with the need to be fiscally sound, the issue of organizational change rises. Beyond NASA and the DOD, the myriad of agencies and organizations involved in space power conflicts with the concept of centralized control and creates organizational inefficiencies. While one single organization may be counter productive, some level of consolidation is warranted. A new organizational approach can streamline the space infrastructure, facilitate greater information sharing, provide robust defenses for all U.S. space activities, and integrate offensive space capabilities to enable effective and efficient exploitation of the space domain.

Conclusion

Space is critical to the United States. This reality dictates fervent pursuit of ways and means to assure operational access to the space domain. This paper illustrates the level of interaction and complexity inherent in the development of space power. Given the increasingly critical role space, the U.S. cannot afford to delay action in dealing with the combination of external threats and internal challenges facing its space power. In a world of scarce resources and growing competition, the United States needs a single, joint approach to guide current operations and future space power development. This paper has clearly shown the space triad should be that approach.

Only through the space triad construct can the U.S. fully address all the critical factors associated with space power. Offensive capabilities are essential to shape the future operational environment and deny the advantages of space to future adversaries. The increasing reliance on space by the DOD and nation at large necessitates robust and multi-layered defensive capabilities. A responsive infrastructure is required to overcome acquisition difficulties and increase the flexibility of U.S. space power to meet unforeseen challenges. Finally, an integrated core of cross-domain situational awareness, C2, and planning is critical to completely leverage all military and national capabilities to achieve the desired space power effects. Adopting the space triad will require many changes.

To fully implement the space triad, the U.S. must alter its approach to space power. First, perceptions about the role of space and the development of space power must change. The DOD must recognize the critical importance of cross-domain capabilities and develop an integrated approach to space operations. To accomplish this, the U.S. will need to recognize intricate linkage between space R&D, acquisitions, and operations. The U.S. should adopt a more balanced approach to its spacelift capabilities. Small payloads and responsive boosters are an

essential element of future U.S. space efforts. As the U.S. moves ahead, it must understand that space is not only a force enhancer, but is also increasingly capable of a decisive role in future crises. Ultimately, the U.S. government must reorganize its space efforts to fully exploit the synergies from the increasing number of current space activities and pave the way for future space enterprises. If the United States is to maintain its preeminence in space it must adopt the space triad.

End Note

[1] "Department of Defense Dictionary of Military Terms," http://www.dtic.mil/doctrine/jel/doddict/.
[2] United States Joint Chiefs of Staff, Joint Doctrine for Space Operations, Joint Publication 3-14 (Washington, D.C.: Joint Chiefs of Staff, 2002), IV-5.
[3] Ibid, GL-6.
[4] Air Force Doctrine Document (AFDD) 2-2, Space Operations (27 November 2006), 1.
[5] Gen. Thomas D. White, "Space Control and National Security," Air Force Magazine 41, no. 4 (1958), 80.
[6] Ibid, 80-83.
[7] David E. Lupton, On Space Warfare: A Space Power Doctrine (Maxwell Air Force Base, Ala.: Air University Press, 1988), 29-37.
[8] Ibid, 60-70.
[9] Air Force Space Command News Services, "Air Force Space Command: Two Decades of Space," SpaceRef.com (2003), http://www.spaceref.com/news/viewpr.html?pid=9111.
[10] Ibid.
[11] Clinton E. Crosier and Naval War College (U.S.). U.S. Space Power: The Achilles Heel of America's Economic Well-Being (Newport, R.I.: Naval War College, 2004).
[12] National Air and Space Intelligence Center, *Challenges to U.S. Space Superiority* (Wright-Patterson Air Force Base, Ohio: National Air and Space Intelligence Center, 2005), 16-24.
[13] Lieutenant General Michael D. Maples, "Current and Projected National Security Threats to the United States" http://www.dia.mil/publicaffairs/Testimonies/statement26.html.
[14] National Air and Space Intelligence Center, Challenges to U.S. Space Superiority, 20.
[15] Simon Elegant and Mark Thompson, "Why China's Missile Test Is Troubling," Time/CNN, http://www.time.com/time/world/article/0,8599,1580595,00.html?cnn=yes.
[16] Senator Wayne Allard, "Speech to Space Policy & Architecture Symposium" (Washington, D.C., September 23 2005).
[17] Richard W. McKinney, "Space Acquisition Today," High Frontier 2, no. 2 (2005), 21.
[18] Robert E. Levin and United States. Government Accountability Office: Defense Acquisitions: Incentives and Pressures That Drive Problems Affecting Satellite and Related Acquisitions (Washington, D.C.: U.S. Government Accountability Office, 2005), 7.
[19] Lieutenant General Michael Hamel, "Building Space Power for the Nation," Air & Space Power Journal - Summer (2006).
[20] United States Congress. Senate Committee on Armed Services. Subcommittee on Strategic., Report of the Commission to Assess United States National Security Space Management and Organization : Hearing before the Subcommittee on Strategic of the Committee on Armed Services, United States Senate, One Hundred Seventh Congress, First Session, March 28, 2001 (Washington: U.S. G.P.O., 2002), 47.
[21] George W. Bush, "U.S. National Space Policy," (Office of Science and Technology Policy, Executive Office of the President, 2006), 1.
[22] Marc Kaufman, "Bush Sets Defense as Space Priority," Washington Post, http://www.washingtonpost.com/wp-dyn/content/article/2006/10/17/AR2006101701484.html?nav=rss_technology/techpolicy.
[23] United States Strategic Command, United States Strategic Command Mission Brief (2006), 3.

[24] General James Cartwright, "Strategic Triad" (paper presented at the IFPA Fletcher Conference Washington, DC, December 15 2005).
[25] Ibid.
[26] Ibid.
[27] Ibid.
[28] United States Joint Chiefs of Staff, Joint Doctrine for Space Operations.
[29] Air Force Doctrine Document (AFDD) 2-2, Space Operations.
[30] John W. Moyle, "The Space and Air Force: One Pathway to the Future," Air University, http://www.airpower.maxwell.af.mil/airchronicles/cc/moyle.html.
[31] Mark E. Harter, "Ten Propositions Regarding Space Power: The Dawn of a Space Force," Air & Space Power Journal Summer (2006).
[32] Carl M. Jones, "The Space Triad: Organizing for an Effective Milspace Deterrent Strategy" (Air Command and Staff College, 2006).
[33] United States Joint Chiefs of Staff, Capstone Concept for Joint Operations, ed. V 2.0 (2005), 16.
[34] _____, Joint Doctrine for Space Operations, IV-8-10.
[35] Staff Sgt. C. Todd Lopez, "Air Force Leaders to Discuss New 'Cyber Command'," http://www.8af.acc.af.mil/news/story.asp?id=123031988.
[36] "Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies," http://www.state.gov/t/ac/trt/5181.htm#treaty.
[37] Bush, "U.S. National Space Policy," 2.
[38] John J. Klein, Space Warfare: Strategy, Principles, and Policy (London; New York, NY: Routledge, 2006), 51.
[39] United States Strategic Command, "(U) Space Control Joint Capabilities Document (Secret//NOFORN)," (2006). Information extracted is unclassified, 10.
[40] Cartwright, "Strategic Triad".
[41] Maj Michael J. Dunn, "Evolution toward the Interoperable Satellite Control Network," High Frontier 2, no. 3 (2006), 53.
[42] United States Joint Chiefs of Staff, Joint Doctrine Command and Control for Joint Air Operations, Joint Publication 3-30 (Washington, D.C.: Joint Chiefs of Staff, 2006), I-1.
[43] United States. Congress. Senate. Committee on Armed Services. Subcommittee on Strategic, Report of the Commission to Assess United States National Security Space Management and Organization : Hearing before the Subcommittee on Strategic of the Committee on Armed Services, United States Senate, One Hundred Seventh Congress, First Session, March 28, 2001, 22.
[44] Michael E. O'Hanlon, Neither Star Wars nor Sanctuary: Constraining the Military Uses of Space (Washington, D.C.: Brookings Institution Press, 2004), 120.
[45] Edgard Schein, "Three Levels of Culture," http://www.12manage.com/methods_schein_three_levels_culture.html.

Bibliography

Air Force Doctrine Document (AFDD) 2-2. *Space Operations*, 27 November 2006.

Air Force Space Command News Services. "Air Force Space Command: Two Decades of Space." *SpaceRef.com* (2003), http://www.spaceref.com/news/viewpr.html?pid=9111.

Allard, Senator Wayne. "Speech to Space Policy & Architecture Symposium." Washington, D.C., September 23 2005.

Bush, George W. "U.S. National Space Policy." 10: Office of Science and Technology Policy, Executive Office of the President, 2006.

Cartwright, General James. "Strategic Triad." Paper presented at the IFPA Fletcher Conference Washington, DC, December 15 2005.

Crosier, Clinton E., and Naval War College (U.S.). *U.S. Space Power: The Achilles Heel of America's Economic Well-Being*. Newport, R.I.: Naval War College, 2004.

Department of Defense Dictionary of Military Terms. http://www.dtic.mil/doctrine/jel/doddict/.

Dunn, Maj Michael J. "Evolution toward the Interoperable Satellite Control Network." *High Frontier* 2, no. 3 (2006): 3.

Elegant, Simon, and Mark Thompson. "Why China's Missile Test Is Troubling." Time/CNN, http://www.time.com/time/world/article/0,8599,1580595,00.html?cnn=yes.

Hamel, Lieutenant General Michael. "Building Space Power for the Nation." *Air & Space Power Journal - Summer* (2006).

Harter, Mark E. "Ten Propositions Regarding Space Power: The Dawn of a Space Force." *Air & Space Power Journal* Summer (2006).

Jones, Carl M. "The Space Triad: Organizing for an Effective Milspace Deterrent Strategy." Air Command and Staff College, 2006.

Kaufman, Marc. "Bush Sets Defense as Space Priority." Washington Post, http://www.washingtonpost.com/wp-dyn/content/article/2006/10/17/AR2006101701484.html?nav=rss_technology/techpolicy.

Klein, John J. *Space Warfare: Strategy, Principles, and Policy*. London; New York, NY: Routledge, 2006.

Levin, Robert E., and United States. Government Accountability Office: *Defense Acquisitions: Incentives and Pressures That Drive Problems Affecting Satellite and Related Acquisitions*. Washington, D.C.: U.S. Government Accountability Office, 2005.

Lopez, Staff Sgt. C. Todd. "Air Force Leaders to Discuss New 'Cyber Command'." http://www.8af.acc.af.mil/news/story.asp?id=123031988.

Lupton, David E. *On Space Warfare: A Space Power Doctrine*. Maxwell Air Force Base, Ala.: Air University Press, 1988.

Maples, Lieutenant General Michael D. "Current and Projected National Security Threats to the United States" http://www.dia.mil/publicaffairs/Testimonies/statement26.html.

McKinney, Richard W. "Space Acquisition Today." *High Frontier* 2, no. 2 (2005): 2.

Moyle, John W. "The Space and Air Force: One Pathway to the Future." Air University, http://www.airpower.maxwell.af.mil/airchronicles/cc/moyle.html.

National Air and Space Intelligence Center. *Challenges to U.S. Space Superiority*. Wright-Patterson Air Force Base, Ohio: National Air and Space Intelligence Center, 2005.

O'Hanlon, Michael E. *Neither Star Wars nor Sanctuary: Constraining the Military Uses of Space*. Washington, D.C.: Brookings Institution Press, 2004.

Schein, Edgard. "Three Levels of Culture." http://www.12manage.com/methods_schein_three_levels_culture.html.

"Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies." http://www.state.gov/t/ac/trt/5181.htm#treaty.

United States Strategic Command. (U) *Space Control Joint Capabilities Document* (Secret//NOFORN). 2006. Information extracted is unclassified.

———. *United States Strategic Command Mission Brief*, 2006.

United States Congress. Senate. Committee on Armed Services. Subcommittee on Strategic. *Report of the Commission to Assess United States National Security Space Management and Organization: Hearing before the Subcommittee on Strategic of the Committee on Armed Services, United States Senate, One Hundred Seventh Congress, First Session, March 28, 2001*. Washington: U.S. G.P.O., 2002.

United States Joint Chiefs of Staff. *Capstone Concept for Joint Operations*. Edited by V 2.0, 2005.

———. *Joint Doctrine Command and Control for Joint Air Operations*, Joint Publication 3-30. Washington, D.C.: Joint Chiefs of Staff, 2006.

———. *Joint Doctrine for Space Operations*, Joint Publication 3-14. Washington, D.C.: Joint Chiefs of Staff, 2002.

White, Gen. Thomas D. "Space Control and National Security." *Air Force Magazine* 41, no. 4 (1958).